CLAIMS

What is claimed is:

1. An electrochemical fuel cell assembly comprising:

a first separator plate having a pair of oppositely facing major planar surfaces, and first and second ports;

a second separator plate having a pair of oppositely facing major planar surfaces, and third and fourth ports;

a membrane electrolyte interposed between said first and second separator plates;

a first electrode interposed between said first plate and said membrane electrolyte, said first electrode comprising a first substrate having a pair of oppositely facing major planar surfaces and electrocatalyst associated therewith defining a first electrochemically active area; and

a second electrode interposed between said second separator plate and said membrane electrolyte, said second electrode comprising a substrate having a pair of oppositely facing major planar surfaces and electrocatalyst associated therewith defining a second electrochemically active area;

said electrochemical fuel cell assembly further comprising a first reactant flow path for directing a first reactant fluid stream between said first and second ports, wherein said first reactant flow path extends substantially linearly across said first electrochemically active area, and said first electrode has an in-plane nonuniform structure in its electrochemically active area as said active area is traversed in the direction of said first reactant flow path.

2. The electrochemical fuel cell assembly of claim 1 wherein the structure of said electrode varies substantially symmetrically as the electrochemically active area thereof is traversed in-plane in the direction of said first reactant flow path.

3. The electrochemical fuel cell assembly of claim 1 wherein said first electrochemically active area is rectangular, and said reactant flow path extends substantially linearly between opposite edges of said rectangular active area.

4. The electrochemical fuel cell assembly of claim 1 wherein said first reactant flow path comprises a plurality of substantially parallel, straight channels formed in a major planar surface of said first separator plate adjacent said first electrode, said channels extending across said first electrochemically active area.

5. The electrochemical fuel cell assembly of claim 1 wherein said electrochemical fuel cell assembly further comprises a second reactant flow path for directing a second reactant fluid stream between said third and fourth ports, wherein said second reactant flow path extends substantially linearly across said second electrochemically active area, and said second electrode has an in-plane nonuniform structure in its electrochemically active area as said active area is traversed in the direction of said second reactant flow path.

6. The electrochemical fuel cell assembly of claim 1 wherein the fluid transport properties of said first electrode substrate vary as it is traversed in-plane in the direction of said first reactant flow path.

7. The electrochemical fuel cell assembly of claim 6 wherein the fluid transport properties of said first electrode substrate vary substantially symmetrically as the electrochemically active area thereof is traversed in-plane in the direction of said first reactant flow path.

8. The electrochemical fuel cell assembly of claim 6 wherein the density of said first electrode substrate increases as it is traversed in-plane in the direction of said first reactant flow path.

9. The electrochemical fuel cell assembly of claim 6 wherein the porosity of said first electrode substrate increases as it is traversed in-plane in the direction of said first reactant flow path.

10. The electrochemical fuel cell assembly of claim 6 wherein the pore size of said first electrode substrate increases as it is traversed in-plane in the direction of said first reactant flow path.

11. The electrochemical fuel cell assembly of claim 1 wherein the material composition of said first electrode substrate varies as it is traversed in-plane in the direction of said first reactant flow path.

12. The electrochemical fuel cell assembly of claim 11 wherein the material composition of said first electrode substrate varies substantially symmetrically as the electrochemically active area thereof is traversed in-plane in the direction of said first reactant flow path.

13. The electrochemical fuel cell assembly of claim 12 wherein said first electrode substrate comprises a coating on one of said major planar surfaces thereof and the loading of said coating varies as the electrochemically active area of said first substrate is traversed in-plane in the direction of said first reactant flow path.

14. The electrochemical fuel cell assembly of claim 12 wherein said first electrode substrate comprises a coating on one of said major planar surfaces thereof and the composition of said coating varies as the electrochemically active area of said first substrate is traversed in-plane in the direction of said first reactant flow path.

15. The electrochemical fuel cell assembly of claim 12 wherein said coating comprises an ion-conducting polymer and the equivalent weight of said polymer coating varies

as the electrochemically active area of said first substrate is traversed in-plane in the direction of said first reactant flow path.

16. The electrochemical fuel cell assembly of claim 1 wherein the material composition of the electrocatalyst associated with said first electrode substrate varies as said electrode is traversed in-plane in the direction of said first reactant flow path.

17. The electrochemical fuel cell assembly of claim 16 wherein the material composition of said electrocatalyst varies substantially symmetrically as said electrode is traversed in-plane in the direction of said first reactant flow path.

18. The electrochemical fuel cell assembly of claim 1 wherein the loading of the electrocatalyst associated with said first electrode substrate varies as said electrode is traversed in-plane in the direction of said first reactant flow path.

19. The electrochemical fuel cell assembly of claim 18 wherein the loading of said electrocatalyst varies substantially symmetrically as said electrode is traversed in-plane in the direction of said first reactant flow path.